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Title: Gender differences in physical activity and sedentary behaviour in adults with intellectual disabilities: A systematic review and meta-analysis

Running title: Gender, Inactivity and Intellectual Disabilities

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ABSTRACT

Background: Adults with intellectual disabilities are reported to be highly inactive, with research required to understand contributory factors. This systematic review aimed to investigate gender differences in physical activity (PA) and sedentary behaviour (SB) in adults with intellectual disabilities.

Methods: This systematic review was reported in accordance with PRISMA guidelines. Seven databases were searched up to, and including, January 2018. Screening identified papers that assessed gender specific PA and/or SB outcomes in adults with intellectual disabilities. Data were synthesised using a narrative synthesis and random effects model meta-analyses.

Results: Twenty-six papers were included; 25 measured PA and eight assessed SB. Women with intellectual disabilities were least active with a significant overall effect of gender identified. For SB, no consistent gender differences were found.

Conclusions: Reflecting the general population, men with intellectual disabilities were most active. Intellectual disability research should consider the role of gender to inform future interventions targeting inactivity.

KEYWORDS

Intellectual Disabilities, Physical Activity, Sedentary Behaviour, Adults, Gender Differences

1. INTRODUCTION

Intellectual disabilities occur prior to the onset of adulthood and result in impairments in both intellectual and adaptive functioning (American Psychiatric Association, 2013). Adults with intellectual disabilities are reported to be inactive (Dairo, Collett, Dawes, & Oskrochi, 2016) and have high rates of sedentary behaviour (SB; Melville et al., 2017). SB consists of behaviours in sitting, reclining or lying positions that do not increase energy expenditure beyond 1.5 metabolic equivalents (METs; Tremblay et al., 2017), while physical activity (PA) requires energy expenditure and includes all bodily movements created by skeletal muscles (Caspersen, Powell, & Christenson, 1985).

Approximately 9% of adults with intellectual disabilities meet PA guidelines (PAG) of 150 min of moderate-to-vigorous PA (MVPA) per week (Dairo et al., 2016) compared to approximately 77% of adults in the general population (Sallis et al., 2009; World Health Organization, WHO, 2018). Furthermore, adults with intellectual disabilities spend approximately 522–643 min/day sedentary (Melville et al., 2017), with over seven hours of SB linked to an increased risk of mortality (Chau et al., 2015). Negative health outcomes, such as obesity and cardiovascular disease, are associated with these low levels of PA and high rates of SB (de Rezende, Lopez, Rey-Lopez, Matsudo, & Luiz, 2014; Warburton, Nicol, & Bredin, 2006).

The negative health outcomes associated with low PA and high SB are reflective of the health inequalities faced by adults with intellectual disabilities, including reduced life expectancy (Heslop et al., 2014), increased prevalence of coronary heart disease (Emerson & Baines, 2011) and obesity (Hsieh, Rimmer, & Heller, 2014; de

Winter, Bastiaanse, Hilgenkamp, Evenhuis, & Echteld, 2012b). Exploration into the distribution of these health inequalities has identified women with intellectual disabilities to have reduced life expectancy (Heslop et al., 2014), higher prevalence of cardiovascular risk factors (de Winter et al., 2012a), and obesity compared to both men with intellectual disabilities and the general population (Emerson, 2005; Hsieh et al., 2014; Melville et al., 2008; Rimmer & Yamaki, 2006; Stancliffe et al., 2011; de Winter et al., 2012b). This apparent trend, with women with intellectual disabilities most at risk of negative health outcomes such as obesity, is potentially reflected in the PA and SB of this population.

In the general population, women engage in less PA (Guthold, Stevens, Riley, & Bull, 2018; Hallal et al., 2012; Trost, Owen, Bauman, Sallis, & Brown, 2002), while men take part in more specific SB such as playing video games (Rhodes, Mark, & Temmel, 2012). When exploring the differences between men and women, the concepts of sex and gender are “entangled” and interact (Springer, Stellman, & Jordan-Young, 2012). Sex refers to the physiological/biological differences, while gender is a psychological and social concept (Madsen et al., 2017) associated with the behaviours (Madsen et al., 2017; Peters & Norton, 2018; Torgrimson & Minson, 2005) and lifestyles (Regitz-Zagrosek, 2012) enacted by men and women, such as PA and SB.

Gender socialization is thought to start from birth (Carter, 2014), with internalized gender roles shaping “gender appropriate” behaviours including participation in PA such as sports (Chalabaev, Sarrazin, Fontayne, Boiché, & Clément-Guillotin, 2013). Research has also uncovered gender-specific environmental (Bengoechea, Spence, & McGannon, 2005) and psychosocial factors, including social

support, motivation and self-efficacy (Edwards & Sackett, 2016), that contribute to the gender differences in PA. Subsequently, gender-tailored interventions have successfully targeted physical inactivity in both men (Wyke et al., 2015) and women (Segar, Jayaratne, Hanlon, & Richardson, 2002).

In adults with intellectual disabilities, no gender-tailored interventions have been developed, while previous mixed-gender interventions have been unsuccessful in significantly increasing PA (McDermott et al., 2012; Melville et al., 2015) and reducing SB (Melville et al., 2015). Surprisingly given the wide research conducted in the general population, and the understanding that women with intellectual disabilities are most at risk of inactivity linked negative health outcomes, such as obesity (Emerson, 2005; Hsieh et al., 2014; Melville et al., 2008), the role of gender in the PA and SB of adults with intellectual disabilities has not been explored. In order to inform future research and the development of successful interventions, there is a need to quantify gender differences in the PA and SB of adults with intellectual disabilities. This systematic review and meta-analysis will be the first to bridge this gap in the literature and provide much needed insight.

1.1 Review Aim

To investigate the presence of gender differences in the PA and SB of adults with intellectual disabilities through a systematic review and meta-analysis.

2. METHODS

This systematic review was reported in accordance with the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009), and a protocol was registered on PROSPERO (CRD42018085544).

2.1 Search Strategy

Seven databases were searched from database inception up to, and including, January 2018: MEDLINE (via Ovid); Embase (Via Ovid); PsycINFO (via EBSCO host); Eric (via EBSCO host); Cinahl (via EBSCO host); Cochrane Library (trials); Web of Science (core collection). Search strategies were developed based on medical subject headings (MeSH) terms and published search strategies (Appendix 1). The search used truncated terms for PA, sedentary behaviour SB and intellectual disabilities, with papers limited to English, full text, humans and adult. Hand searches were conducted through reference lists of relevant systematic reviews identified by the search strategy and studies selected for full-text screening.

2.2 Primary Outcomes

- Gender differences in the PA of adults with intellectual disabilities across multiple PA domains such as frequency, intensity, duration and mode.

- Gender differences in the SB of adults with intellectual disabilities including engagement in SB and time spent sedentary (sedentary time; ST).

2.3 Eligibility Criteria

The following eligibility criteria determined the inclusion of papers during screening:

Inclusion Criteria

- Adults (≥ 18 years) with intellectual disabilities.
- Quantitative objective and/or subjective data for PA and/or SB.

Exclusion Criteria

- $\leq 50\%$ of participants are adults (indicated by age range, mean or ability to extract data separately for adults).
- $\leq 50\%$ of participants have intellectual disabilities.
- PA or SB not reported for men or women with intellectual disabilities.
- Literature reviews, meta-analyses, protocols and qualitative research.
- Not English language.

A cut-off of 50% was used as criteria for adults and intellectual disabilities to ensure all potentially relevant papers were included.

2.4 Study Selection

Records were transferred into Covidence software (<https://www.covidence.org>) for screening, and duplicates were removed. Title and abstract screening and full text screening were conducted independently by two researchers. Conflicts were discussed between researchers until a consensus was reached. Cohen's kappa scores were calculated using SPSS (version 23; IBM, NY, USA) to assess inter-rater reliability, which demonstrated substantial agreement (Landis & Koch, 1977) for both title and abstract screening ($\kappa = .633$) and full text screening ($\kappa = .789$).

2.5 Data Extraction

Two reviewers independently extracted all relevant data. A data extraction tool was developed using excel to ensure extracted data described the general study characteristics (bibliographic data; study aim; country; study design; recruitment; sample characteristics), PA and SB measurement (objective or subjective; measurement tool; measurement method), and the PA or SB outcomes reported for men and women.

2.6 Data Synthesis

A narrative synthesis was conducted for all PA and SB data reported in the studies with findings compared between genders. Where appropriate, weighted averages were calculated for PA and SB data. The averages were weighted by the number of men or women within a study (Appendix 2). Meta-analyses were conducted to assess the direction and magnitude of the effect of gender for PA and SB using Reviewer Manager

(RevMan, Version 5.3. Copenhagen, The Cochrane Collaboration, 2014). Separate meta-analyses were conducted for step counts, MVPA and ST as sufficient citations were available. Mean scores, standard deviations and total numbers of men / women in a study were used. Standardised mean difference was used as the summary statistic to calculate the effect size as studies used different measures for the same outcome. A random effects model was implemented as a common effect size could not be assumed (Borenstein, Hedges, Higgins & Rothstein, 2010). Cohen's d effect sizes are classed as small ($d = 0.20$), medium ($d = 0.50$), large ($d = 0.80$) and very large ($d = 1.20$; Cohen, 1988).

2.7 Quality Appraisal

Quality was appraised using The Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields quantitative checklist (Kmet, Lee & Cook, 2004). This tool can be applied to a range of study designs and therefore fits the design of this systematic review. Studies were assessed against a 14-item checklist and scores based on the attainment of each item: yes = 2; partial = 1; no = 0; N/A. N/A responses were removed to provide an accurate calculation of quality as a percentage. Quality appraisal was independently conducted by two researchers, with discrepancies discussed. Cohen's kappa scores were calculated using SPSS (version 23; IBM, NY, USA) to assess inter-rater reliability for all quality appraisal questions, which demonstrated substantial agreement ($\kappa = 0.679$; Landis & Koch, 1977).

3. RESULTS

3.1 Literature Search

Following duplicate removal, n = 11238 titles and abstracts and n = 79 full text articles were screened. Twenty-six papers were included in the review, with one study originating from the hand search. Most papers were excluded at full-text screening because gender differences in physical activity (PA) or sedentary behaviour (SB) were not assessed (Figure. 1, PRISMA flow chart). Two studies (Stanish & Draheim, 2005, 2007) used the same data, but assessed different outcomes; therefore both studies were included.

***** INSERT FIGURE ONE HERE *****

Figure. 1. PRISMA flow chart of study selection

3.2 Study Characteristics

This review has an international scope, with studies conducted across numerous different countries with varying study designs also employed (Table 1). Fifteen studies objectively measured PA or SB, via accelerometers or pedometers (Barnes, Howie, McDermott, & Mann, 2013; Bodde, Seo, Frey, Puymbroeck, & Lohrmann, 2013; Finlayson, Turner, & Granat, 2011; Hilgenkamp, Reis, Wijck, & Evenhuis, 2012; Johnson, Yun, & McCubbin, 2014; Lante, Walkley, Gamble, & Vassos, 2011; Moss & Czyz, 2018; Nordstrom, Hansen, Paus, & Kolset, 2013; Oviedo, Travier, & Guerra-Balic,

2017; Phillips & Holland, 2011; Stanish, 2004; Stanish & Draheim, 2005, 2007; Sundahl, Zetterberg, Wester, Rehn, & Blomqvist, 2016; Temple & Stanish, 2009; Table 1). Subjective self-report or proxy measurements were utilized in 14 studies (Draheim, Williams, & McCubbin, 2002; Emerson, 2005; Finlayson et al., 2009, 2011; Fujiura, Fitzsimons, Marks, & Chicoine, 1997; Hsieh, Heller, Bershadsky, & Taub, 2015; Hsieh, Hilgenkamp, Murthy, Heller, & Rimmer, 2017; Johnson et al., 2014; McGuire, Daly, & Smyth, 2007; Melville et al., 2018; Moss & Czyz, 2018; Robertson et al., 2000; Soler Marin & Graupera, 2011; Stancliffe & Anderson, 2017; Table 1). Three studies combined objective and subjective measurements of PA or SB (Finlayson et al., 2011; Johnson et al., 2014; Moss & Czyz, 2018).

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Table 1. Study Characteristics and Quality Appraisal Scores

3.3 Participant Characteristics

Sample size ranged from n = 2 (Lante et al., 2011) to n = 8636 (Stancliffe & Anderson, 2017). Participant age ranged from 12 – 94 years. The percentage of female participants ranged from 36.9% (Stanish & Draheim, 2005, 2007) to 62% (Nordstorm et al., 2013). All studies included participants with mild to moderate ID, with ten studies including severe and profound intellectual disabilities levels (Finlayson et al., 2009; Fujiura et al., 2011; Hsieh et al., 2015, 2017; McGuire et al., 2007; Melville et al., 2018; Oviedo et al., 2017; Phillips & Holland, 2011; Soler Marin & Graupera, 2011; Stancliffe

& Anderson, 2017). Race/ethnicity was only reported by eight studies (Barnes et al., 2013; Bodde et al., 2013; Emerson, 2005; Finlayson et al., 2011; Fujiura et al., 2011; Hsieh et al., 2015; Hsieh et al., 2017; Robertson et al., 2000). Barnes et al., (2013) reported most of their participants to be non-Hispanic Black (58.8%), while the remaining seven studies stated that 70.1% (Hsieh et al., 2015) to 98% (Emerson, 2005) of participants were White/Caucasian.

3.4 Quality Appraisal

Quality appraisal was conducted for all studies (Table 1). The quality of papers was variable and ranged from a weak (lowest score of 45%; Robertson et al., 2000) to strong quality (highest score of 95%; Finlayson et al., 2009; Melville et al., 2018; Phillips & Holland., 2011; Stanish & Draheim, 2005; Temple & Stanish, 2009; Hsieh et al., 2017). The diverse study quality needs to be considered when deliberating the results.

3.5 Gender Differences in Physical Activity

Twenty-five of the included citations assessed PA. Gender differences were reported according to the PA described in the studies: step counts; moderate to vigorous PA (MVPA); total PA; PA levels and intensity; physical inactivity; PA frequency; leisure time PA (LTPA).

3.5.1 Gender Differences in Steps

Step counts were reported as steps per day (Finlayson et al., 2011; Hilgenkamp et al., 2012; Johnson et al., 2014; Nordstorm et al., 2013; Oviedo et al., 2017; Phillips & Holland, 2011; Stanish, 2004) and per week (Stanish & Draheim, 2005; Sundahl et al., 2016). One study reported that gender differences in weekly steps were not significant, without supporting descriptive statistics (Temple & Stanish, 2009). Significant gender differences were reported by four studies, with men most active (Finlayson et al., 2011; Hilgenkamp et al., 2012; Nordstorm et al., 2013; Phillips & Holland, 2011). Steps/week ranged from 49,590 to 55,703 for men and 40,539 to 53,312 for women. The daily number of steps reported for men across the studies (range: 6,389 to 11,101 steps/day) was higher than that accumulated by women (range: 5,741 to 10,811 steps/day). The calculated weighted average of daily steps suggests men were more active accumulating 7,289.38 steps/day compared to 6,135.2 steps/day for women.

******* INSERT FIGURE TWO HERE *******

Figure. 2. Meta-analysis results and forest plot for gender differences in steps

The meta-analysis uncovered a significant small overall effect of gender ($d = 0.34$, 95% CI [0.12, 0.57], $P = 0.003$) in the direction of men accumulating more steps (Figure. 2). Significant heterogeneity between studies was found ($P = 0.02$, $I^2 = 55\%$) and an $I^2 > 50\%$ suggests that inconsistencies were due to factors within the papers rather than chance. Large confidence intervals indicate limited precision in the

findings. However, overall the meta-analysis demonstrates that men accumulate more steps than women with intellectual disabilities.

3.5.2 Gender differences in Moderate to Vigorous Physical Activity

Gender was significantly correlated with MVPA with fewer men (33.3%) than women (61.9%) accumulating 0 min/day of MVPA (Bodde et al., 2013). Weekly MVPA was significantly higher in men ($M = 134.9$ min/week) than women ($M = 85.7$ min/week; Barnes et al., 2013). These gender differences were present in daily MVPA measured using ActiGraph accelerometers, with men most active (men = 32.1 to 40.4 MVPA min/day; women = 22 to 30.2 MVPA min/day; Nordstorm et al., 2013; Oviedo et al., 2017; Phillips & Holland, 2011). The gender differences in daily MVPA were reported as significant by two studies (Nordstorm et al., 2013; Phillips & Holland, 2011). The calculated weighted average reflected these differences, with men (36.8 min/day) accumulating more minutes of daily MVPA than women (27.3 min/day).

***** INSERT FIGURE THREE HERE *****

Figure. 3. Meta-analysis results and forest plot for gender differences in MVPA

The meta-analysis (Figure 3) supported the presence of gender differences for MVPA with a significant small overall effect reported for men ($d = 0.45$, 95% CI [0.25, 0.64], $P < 0.001$). Limited variability in the effect sizes were identified with the test for

heterogeneity reporting insignificant results ($P = 0.36$; $I^2 = 7\%$). Overall the results show that men participated in more MVPA.

3.5.3 Gender Differences in Recommended Physical Activity Levels

Percentage meeting recommended PA levels across the five studies ranged from 5.6% to 42.9% of men and 2.9% to 29% of women, indicating men are more active. Being female was reported to be significantly associated with not meeting the PA recommendation of 150 minutes/week of MVPA in adults with intellectual disabilities (Hsieh et al., 2015). However, across the studies different definitions of recommended PA levels were: 30 minutes of MVPA/day (Stancliffe & Anderson, 2017); 150 minutes of MVPA/week (Hsieh et al., 2015; Oviedo et al., 2017); high levels of PA (Finlayson et al., 2009); 10,000 steps/day (Hilgenkamp et al., 2012; Oviedo et al., 2017; Sundahl et al., 2016); 7500 steps/day (Hilgenkamp et al., 2012). Although the recommended PA ranges indicate that men were most active, it is difficult to make comparisons due to variations in recommended PA levels.

3.5.4 Gender Differences in Total Physical Activity

Subjectively measured total weekly PA identified men as engaging in significantly more PA ($M = 259.9$ ($SD = 390$) min/week) than women ($M = 80.5$ ($SD = 123.9$) min/week; Moss & Czyz, 2018). Descriptively, daily total PA was higher for men ($M = 131654.11$ ($SD = 69159.18$) counts/day) than women ($M = 128962.24$ ($SD = 49269.98$) counts/day; Johnson et al., 2014). However, women had more self-reported PA bouts ($M = 13.36$

($SD = 6.75$) bouts) than men ($M = 11.91$ ($SD = 4.08$) bouts; Johnson et al., 2013). Results for objectively measured total PA as counts per minute (cpm) using ActiGraph GT1M and GT3X accelerometers ranged from 260.2 to 665.0 cpm for men compared to 240.2 to 564.1 cpm for women (Nordstorm et al., 2013; Phillips & Holland, 2011; Oviedo et al., 2017), with men significantly more active (Nordstorm et al., 2013; Phillips & Holland, 2011). A weighted average based on gender found men (470.5 cpm) to be more active than women (398.5 cpm)

3.5.5 Gender Differences in Physical Activity Levels and Intensity

Varying measurements and definitions were used for PA levels and percentages within PA intensity reducing the ability to make comparisons. When using PA level cut points of light PA (1.4 – 1.6) and sedentary (<1.4), women were reported to engage in light PA (1.45 PAL) while men were classified as sedentary (1.33 PAL; Moss & Czyz, 2018). Light intensity PA assessed as min/day using ActiGraph accelerometers ranged from 130.5 to 227 min/day in men, and 125.2 to 203 min/day for women (Nordstorm et al., 2013; Oviedo et al., 2017) highlighting that more men engage in light PA.

Percentages of low levels of PA ranged from 55.5% to 68% for men, and 65.2% to 68% for women (Finlayson et al., 2009; Hsieh et al., 2017) with low PA described as ≤ 3 occasions of MVPA/month (Finlayson et al., 2009) or little to no PA (Hsieh et al., 2017). Significant gender differences were reported by Hsieh et al., (2017), with women having the lowest levels of PA. Soler Marin and Graupera, (2011) used a subjective measure of PA that classified both men and women as engaging in low PA

levels reporting insignificant gender differences, however this methodology prevents comparisons with other studies.

When assessing percentages within PA levels, Finlayson et al. (2009) reported that 27% of both genders engaged in medium PA levels (4 – 19 occasions of MVPA/month), and 5% of women and 6% of men engaging in high intensity PA (≥ 20 occasions of MVPA/month). The percentage engaging regular PA at any intensity was 74.1% of men and 70.6% of women for 2.9 hr/week and 2.5 hr/week respectively (Finlayson et al., 2009). Thirty-five percent of both men and women engaged in at least moderate intensity PA a week (men - 1.8 hr/week; women – 1.5 hr/week; Finlayson et al., 2009).

Reported percentages of men and women in low active to somewhat active categories based on steps indicated the presence of gender differences (low active – 63% men / 37% women; somewhat active – 68% men / 32% women; active – 64% men / 36% women), however percentages reflected the relative proportion of men / women in each group rather than gender differences (Stanish & Draheim, 2007).

One study reported percentage engaging in each intensity across a week, segmented for age: light intensity PA (16 – 29 years: men = 46.2%; women = 44.4% / 30 – 59 years: men = 40%; women = 66.7%), moderate intensity PA (16 – 29 years: men = 38.5%; women = 27.8% / 30 – 59 years: men = 6.7%; women = 66.7%) and strenuous intensity PA (16 – 29 years: men = 7.7%; women = 5.6% / 30 – 59 years: men = 6.7%; women = 0%; Fujiura et al., 1997). Participants aged 30 – 59 years reported greater gender differences, with older women more likely to engage in light or moderate PA, but report less strenuous PA.

3.5.6 Gender Differences in Physical Inactivity

Physical inactivity, the lack of PA, was assessed by two studies (Emerson, 2005; Robertson et al. 2000). One study reported female gender to be significantly associated with physical inactivity (Emerson, 2005) while the other found insignificant gender differences (Robertson et al., 2000). Importantly, quality appraisal classified Robertson et al. (2000) as being of weak quality, while Emerson (2005) was of strong quality with a low risk of bias. Emerson (2005) also classified participants based on physical abilities, and descriptively the biggest gender differences were found in the ages 16 – 24 years (excluding participants with intellectual disabilities who were “physically incapable”: men = 83%; women = 100% / all adults with ID: men = 88%; women = 100%) and ages 35 - 44 years (excluding participants with intellectual disabilities who were “physically incapable”: men = 89%; women = 97% / all adults with ID: men = 93%; women = 98%). These results suggest that age and physical capability influence the effect of gender.

3.5.7 Gender Differences in Physical Activity Frequency

The frequency adults with intellectual disabilities exercise per week was subjectively assessed (McGuire et al., 2007). No significant difference was identified in the frequency of weekly exercise (men = 4.36 times/week; women = 4.28 times/week). Although this suggests no gender differences in PA frequency, these findings were based on one study.

3.5.8 Gender Differences in Leisure Time Physical Activity

Physical activity conducted during leisure time, or leisure time PA (LTPA), was assessed in adults with intellectual disabilities (Nordstorm et al., 2013; Draheim et al., 2002). No significant gender differences were reported across the categories of no LTPA/week (men = 10.5%; women = 14.9%), little to no LTPA/week (men = 51.3%; women = 47.3%), regular vigorous LTPA/week (men = 1.3%; women = 1.4%) and recommended LTPA/week (men = 42.1%; women = 47.3%; Draheim et al., 2002). However, men were significantly more active than women when assessed as minutes per day ($M = 86.0$ ($SD = 39.6$) min/day and $M = 62.3$ ($SD = 25.6$) min/day respectively; Nordstorm et al., 2013).

Lante et al. (2011) compared the PA of two participants of opposite genders during a leisure facility-based PA programme and non-programme weekdays and weekends, with data collected two years apart. During the PA programme MVPA/hr (man = 4.27 – 6.13 min/hr; woman = 9.21 – 14.34 min/hr), steps/hr (man = 864.55 – 1144.76 steps/hr; woman = 1268.88 – 1333.64 steps/hr) and light PA/hour (man = 45.02 – 40.67 min/hr; woman = 45.54 – 33.39 min/hr) were assessed. PA measured during non-programme days would have originated from daily activities with data on MVPA/hour (man = 0.67 – 2.09 min/hr; woman = 0.4 – 1.56 min/hr), steps/hr (man = 297.7 – 560.62 steps/hr; woman = 208.32 – 386.04 steps/hr) and light PA/hr (man = 57.91 – 59.32 min/hr; woman = 58.44 – 59.60 min/hr) gathered. A significant difference was only reported between the participants during the PA programme, with the female participant accumulating significantly more MVPA min/hr. However,

although this study met eligibility criteria, the design and reporting of PA outcomes prevents comparisons with other studies or conclusions regarding gender differences being formed.

3.6 Gender Differences in Sedentary Behaviour

Eight studies made comparisons between genders for SB (Finlayson et al., 2011; Hsieh et al., 2017; Melville et al., 2018; Moss & Cxyz, 2018; Nordstorm et al., 2013; Oviedo et al., 2017; Phillips & Holland, 2011; Stanish & Draheim, 2007; Table 1). One study misclassified SB as engaging in <5000 steps / day, with more men classed as sedentary (men = 58%; women = 42%; Stanish & Draheim, 2007); however, percentages represented proportion of each gender in a category. Objectively measured PA levels resulted in only men meeting criteria for being sedentary (Moss & Cxyz, 2018).

Sedentary time (ST) has been measured both objectively (Finlayson et al., 2011; Nordstorm et al., 2013; Oviedo et al., 2017; Phillips & Holland., 2011) and subjectively (Hsieh et al., 2017; Melville et al., 2018). When assessed subjectively using proxy measures of ST such a screen time, men had higher levels of ST (Melville et al., 2018; Hsieh et al., 2017). Descriptively more men were classified in a high ST category (men = 53.6%; women = 47.7%), while more women engaged in low ST (men = 46.4%; women= 52.3%). However, gender was only found to be significantly associated with ST during a multivariate analysis and the bivariate analysis was insignificant (Melville et al. 2018). Hsieh et al., (2017) also reported males to be more sedentary, with men

accumulating significantly more hours watching television ($M = 3.55$ ($SD = 2.17$) hr) than women ($M = 3.26$ ($SD = 2.04$) hr).

Contrasting findings were reported for objectively measured ST, with significantly more women sedentary than men (Finlayson et al., 2011; Phillips & Holland, 2011). Men were reported as sedentary for $M = 17.62$ ($SD = 1.36$) hr/day and women for $M = 19.56$ ($SD = 1.82$) hr/day (Finlayson et al., 2011), with minutes of daily ST ranging from 511 to 607.7 min/day for men, and 528 to 620.2 min/day for women (Nordstorm et al., 2013; Oviedo et al., 2017; Phillips & Holland, 2011). A weighted average was calculated for sedentary minutes per day assessed objectively (Nordstorm et al., 2013; Oviedo et al., 2017; Phillips & Holland, 2011). No gender differences were supported by the weighted average (men = 586.1 min/day; women = 588.5 min/day); however this was based on limited studies.

The results of the meta-analysis supported this (Figure. 4) with an insignificant overall effect of gender ($d = -0.21$, 95% CI [-0.53, -0.12], $P = 0.21$). There was significant heterogeneity among the studies, with an I^2 that indicates that inconsistencies in results were due to a factor within studies rather than chance ($P < 0.001$, $I^2 = 79\%$).

***** INSERT FIGURE FOUR HERE *****

Figure. 4. Meta-analysis and forest plot for gender differences in ST

4. DISCUSSION

This systematic review was the first to quantify gender differences in PA and SB in adults with intellectual disabilities. The studies selected were international with research originating from numerous different countries. Full-text screening highlighted a tendency for intellectual disability PA or SB research to neglect the role of gender. Mixed findings reported by the narrative synthesis of PA contrast with the significant gender differences reported by the meta-analysis of step counts and MVPA. For SB, the results were inconclusive due to insufficient studies, varying methodologies and mixed findings.

4.1 Gender Differences in Physical Activity

Gender differences were assessed across numerous PA domains, reducing the ability to make comparisons between studies. This could be partially attributed to PA not always being a primary outcome, which resulted in the measurement method not being optimal. The narrative synthesis identified women as accumulating less step counts and MVPA, but reported mixed findings relating to gender in the other PA domains. Due, in part, to varying definitions of recommended PA levels, the measurements employed to assess PA. The measurement method was identified as important when investigating gender differences, as two studies reported discrepancies in results dependent on the measurement used (Johnson et al., 2014; Moss & Cxyz, 2018). Accelerometer (Johnson et al., 2014) and proxy-respondent International PA questionnaire—short form (Moss & Cxyz, 2018) data identified men

as more active, while pedometer (Johnson et al., 2014) and ACTi heart data (Moss & Czyz, 2018) reported women as most active.

The results of the meta-analyses of objectively measured step counts and MVPA offer the best evidence, as pedometer and accelerometers provide a more valid measurement than subjective self-reported PA (Esliger & Tremblay, 2007). The results indicate that men with intellectual disabilities engage in more PA, which is reflective of the general population. A stronger effect of gender was reported for MVPA ($d = 0.45$) compared to step counts ($d = 0.34$). This finding is supported in the general population, as men are reported to engage in significantly more sports and exercise, yet there are no gender differences present in recreational walking (Scottish Government, 2015). Sports in the general population can also be appraised as being stereotypically masculine, feminine or neutral (Plaza, Boiché, Brunel, & Ruchaud, 2017; Schmalz & Kerstetter, 2006) which can influence participation (Schmalz & Kerstetter, 2006), suggesting the type of PA may be important to future research exploring the role of gender in the PA of adults with intellectual disabilities. Although this review provides insight into the presence of gender differences, the ability to make meaningful conclusions is threatened by recurring limitations in the literature.

Sampling limitations such as the recruitment from single locations (Fujiura et al., 1997; McGuire et al., 2007; Oviedo et al., 2017) and the use of very small samples (Bodde et al., 2013; Fujiura et al., 1997; Johnson et al., 2014; Moss & Czyz, 2018; SolerMarin & Graupera., 2011; Stanish, 2004; Sundahl et al., 2016) reduces reliability and the generalizability of the results to the wider population of adults with intellectual disabilities. The inclusion of studies such as Stanish (2004), with a sample

of $n = 8$ males and $n = 12$ females, into the meta-analysis of step counts contributed to the wide confidence intervals, significant heterogeneity and inconsistencies in the results. The varying definitions of PA, such as recommended PA levels ranging from 7,500 steps/day to 150 min of weekly MVPA, impaired the ability to make comparisons.

Nonetheless, the meta-analyses of MVPA and step counts, and the narrative synthesis of studies with large representative samples (Emerson, 2005; Hsieh et al., 2015, 2017; Stancliffe & Anderson, 2017), identified women with intellectual disabilities as being least active. This is an important finding as it reflects the distribution of associated negative health outcomes in this population (Emerson, 2005; Hsieh et al., 2014; Melville et al., 2008), and due to the PA levels of adults with intellectual disabilities being so low (Dairo et al., 2016).

The review also identified non-modifiable influences of the effect of gender such as age (Fujiura et al., 1997; Emerson, 2005) and physical capability (Emerson, 2005). In adults with intellectual disabilities, PA is associated with modifiable psychosocial factors such as social support and self-efficacy (Peterson et al., 2008), which contribute to the presence of gender differences in the general population (Edwards & Sackett., 2016). However, little is known about psychosocial or environmental factors that may influence the impact of gender on the PA of adults with intellectual disabilities, suggesting a need for more research. Fully understanding the role of gender will inform the development of interventions to target inactivity, which have been largely unsuccessful in this population (McDermott et al., 2012; Melville et al., 2015).

4.2 Gender Differences in Sedentary Behaviour

Gender differences were not consistently reported for SB, with an insignificant overall effect reported by the meta-analysis. The absence of significant gender differences was surprising based on the distribution of health inequalities in adults with intellectual disabilities, with women most at risk (Emerson, 2005; Hsieh et al., 2014; de Winder et al., 2012). However, the discrepancies in results based on objective total sedentary time and subjective screen time are reflective of the inconsistent findings in the general population, with men only identified as significantly more sedentary for specific behaviours such as video game playing (Rhodes et al., 2012). Providing a potential explanation for proxy measures of ST, such as television viewing, reporting men with intellectual disabilities as significantly more sedentary (Hsieh et al., 2017). However, it is difficult to generalize findings for specific SB, such as screen time and television viewing, to describe gender differences in all SB in adults with intellectual disabilities. Although more feasible when assessing SB in large samples, subjective and proxy measures of SB are less valid than objective assessments of ST using accelerometers.

The lack of gender differences contradicts results for PA, reinforcing that these behaviours are distinct. It is therefore alarming that one study included in this review misclassified low PA (5,000 daily steps) as SB, which is a recurring limitation in intellectual disability research (Melville et al., 2017). It is also difficult to make robust conclusions regarding gender differences in SB, as limited studies were identified. There is a dearth of literature specifically assessing SB in adults with intellectual disabilities, which reduces the ability to make conclusions. Therefore, more research is

required assessing SB in adults with intellectual disabilities considering the role of gender, with the definition of SB taken into consideration as a potential influence.

4.3 Strengths and limitations

This systematic review followed PRISMA guidelines, thus reducing risk of bias. Two researchers conducted the screening, data extraction and quality appraisal, further reducing bias in the review. Numerous papers were screened, and additional hand searches were conducted reducing the omission of relevant papers. This systematic review also addressed an important gap in the literature, and the results can be used to guide future research. The results also have improved generalisability due to the international scope of the review, with studies included from numerous countries. However, limitations are present that were partly unescapable due to the nature of the research reviewed.

The studies included in this systematic review used varied PA and SB definitions and measurements reducing the reliability of comparisons made. Numerous studies assessed PA and SB as secondary outcomes, and as a result the measurement methods used were often subjective with reduced validity. Important participant characteristics such as ethnicity/race were only reported by eight studies reducing the representativeness and generalisability of the results. There were also limited studies included in the meta-analyses, however, this was unavoidable due to the tendency of intellectual disabilities research in PA and SB to neglect the role of gender and due to the variations in PA and SB constructs assessed. Studies with small samples may have also impaired the precision and reliability of the meta-analyses. Additionally, poor quality papers were included in the review potentially harming the validity of

conclusions made; however, these papers are reflective of the quality of some intellectual disabilities literature, highlighting a need for improved methodological rigour and a need for intellectual disabilities research to consider the role of gender.

5. CONCLUSION

This study was the first to quantify gender differences in the PA and SB of adults with ID. Women with intellectual disabilities were identified as engaging in less PA, which is reflective of the general population and prevalence of associated negative health outcomes such as obesity in adults with intellectual disabilities. No clear gender differences were reported for SB, with results based on limited studies. A tendency for PA and SB research recruiting adults with intellectual disabilities to neglect the influence of gender was identified during screening, with most excluded papers not reporting results for males and females separately. Recurring limitations within the included articles were also highlighted, indicating a need for improved quality research considering gender differences in the PA and SB of adults with intellectual disabilities using valid measurements. Future research should also aim to understand the role of gender in these health behaviours, in order to inform the development of successful interventions to target the unhealthy low levels of PA in adults with intellectual disabilities.

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Table 1. Study Characteristic and Quality Appraisal Scores

Author (Year)	Country	Sample size (% female; % f)	Study Design	Age range	ID level	PA Assessed	Objective measurement PA	Subjective measurement PA (Respondent)	SB assessed	Objective measurement SB	Subjective measurement SB	Quality Score
Barnes et al. (2013)	USA	n = 131 (PA data; 46.6% f)	Cross-sectional	18-65	Mild to moderate	MVPA (min/ week)	ActiGraph accelerometer	N/A	N/A	N/A	N/A	90%
Bodde et al. (2013)	USA	n = 42 (50% f)	Cross-sectional “Part of larger intervention study”	19 - 62	Mild to moderate	MVPA (min/ day)	ActiGraph accelerometer	N/A	N/A	N/A	N/A	65%
Draheim et al. (2002)	USA	n = 150 (49.33% f)	Cross-sectional	19 - 65	Mild to moderate	LTPA: No / Little to No / Moderate to Vigorous	N/A	The National Health and Nutrition Examination Survey III, PA Survey (participant and carer)	N/A	N/A	N/A	85%
Emerson (2005)	England	n = 1458 (PA data) (47.5% f)	Cross-sectional	16 - 75+ (M = 49.3)	NS	Percentage inactive	N/A	Health Survey for England 1993 – 1998 PA scale (“key informant”)	N/A	N/A	N/A	90%
Finlayson et al. (2009)	Scotland	n = 433 (46.4% f)	Prospective cohort design	NR (M = 44.1)	Mild to profound	Levels of PA / regular low levels of PA	N/A	Purpose-designed semi-structured interviews (participants)				95%
Finlayson et	Scotland	n = 41 (56.1%	Observational	18-60 (PA	Mild to	Steps;	ActivPAL	Semi-structured	ST	activPAL	N/A	90%

al. (2011)		f) full PA data	cohort design	data)	moderate	Moderate PA; ≥30 minute bouts of moderate PA	Accelerometer	interviews: self-reported regular level and pattern of PA over 7 days (Participant)		Accelerometer		
Fujiura et al (1997)	USA	n = 49 included in analyses (42.9% f)	Cross-sectional	16-59 (M = 29.5)	Mild to severe	PA levels	N/A	Telephone interview: adapted “Health Habits and History Questionnaire”; HHHQ (parents; other family members)	N/A	N/A	N/A	70%
Hilgenkamp et al. (2012)	Netherlands	n = 257 (48.2% f) sub-sample of n = 1050	Cross-sectional	50 – 94	Mild to Severe *Borderline (4.4%); Unknown (1.9%)	Steps; PAG	NL-1000 pedometer.	N/A	N/A	N/A	N/A	90%
Hsieh et al. (2015)	USA	n = 4282 (43.4% f)	Secondary data analysis	20 - 60+	Mild to Profound	PAG	N/A	Background information from section I & II through of the adult consumer survey (Caregiver)	N/A	N/A	N/A	85%
Hsieh et al. (2017)	USA	n = 1618 (44.8% f)	Baseline of longitudinal study	18-86	Mild to profound ID; *27% had data missing or an	Low levels PA	N/A	Self/proxy report response to a questionnaire (Parents;	ST (hours spent watching TV)	N/A	Self/proxy reported time watching TV (Parents; healthcare providers;	85%

					unknown level of ID			healthcare providers; residential or day program staff; relatives other than parents or non- related live-in carers; adult with ID)			residential or day program staff; relatives other than parents or non- related live-in carers; adult with ID)	
Johnson et al. (2014)	USA	n = 37 (56.8% f)	Cross-sectional	19-74	NS	Steps (pedometer) ; activity cpm (accelerometer); PA bouts (interview)	Actiwatch Accelerometer; Pedometers (Omron HJ-112)	NHANES III PA interviewer administered survey (participant with assistance)	N/A	N/A	N/A	90%
Lante et al. (2011)	Australia	n = 2 (50% f)	Case study	21-22	Mild	Light intensity min/hour; MVPA min/hour; Steps /hour	Actigraph Accelerometer (GT1M)	N/A	N/A	N/A	N/A	65%
McGuire et al. (2007)	Republic of Ireland	n = 157 (46.5% f)	Cross-sectional	16-65 (M = 37)	Mild to Profound *N = 1 borderline; N = 1 unknown	PA intensity (no exercise; mild; moderate; strenuous)	N/A	Questionnaire adapted from the National health and lifestyles survey (Carer)	N/A	N/A	N/A	65%
Melville et al. (2018)	Scotland	n = 725 (45% f)	Population-based, cross-sectional study	18-90	Mild to Profound	N/A	N/A	N/A	Screen time as a proxy for ST (hours monthly to daily)	N/A	Interview question (Participants with support from carers)	95%

Moss & Czyz (2018)	S.Africa	n = 56 (50%f)	Cross-sectional	25-62	Mild to moderate	PA levels; Continuous habitual activity energy expenditure; IPAQS Total PA in minutes	Actiheart Accelerometer	International physical activity questionnaire (IPAQ-S) (caregiver)	Sedentary Mets (<1.4)	Actiheart Accelerometer	N/A	85%
Nordstrom et al (2013)	Norway	n = 87 (62% f)	Cross-sectional	16-45 (M = 28.5)	Mild to moderate *based on intellectual disabilities associated with developmental disabilities	Steps/day; PA intensity (light PA; MVPA) min/day; lifestyle PA; Bouts MVPA (min/day)	Actigraph Accelerometer (GT3X+)	N/A	ST (min/day)	Actigraph Accelerometer (GT3X+)	N/A	90%
Oviedo et al. (2017)	Spain	n = 84 included in analysis (41.6% f)	Cross-sectional	NR (M = 44)	Mild to Severe	Total PA cpm; steps/day; PA levels	ActiGraph accelerometer (GT3X)	N/A	ST (min/day)	ActiGraph accelerometer (GT3X)	N/A	80%
Phillips & Holland. (2011)	England	n = 152 included in the analysis (51% f)	Cross-sectional	12 - 70yrs (M = 33.6)	Mild to severe	Total PA cpm; PAL; MVPA min/day; Steps	Actigraph GT1M accelerometer	N/A	ST (min/day)	ActiGraph accelerometer (GT1M)	n/a	95%
Robertson et al. (2000)	United Kingdom	n = 500 (39.8% f; estimated)	Cross-sectional	m = 40.1 (village group); M = 47.5 (NHS campus); M = 45.5 (Disperse	NR	Percentage inactive	N/A	Semi-structured interview: Health Survey For England 1993 & 1996; Tameside and Glossop Health Needs Survey	N/A	N/A	N/A	45%

Physical Activity in Older Adults with Cognitive Impairment: A Systematic Review of Cross-Sectional Studies												
Study	Country	Sample Size (n)	Study Design	Participant Characteristics		Physical Activity Measure	Physical Activity Assessment	Cognitive Assessment		Caregiver	Physical Activity Prevalence	Physical Activity Prevalence (95% CI)
				Age (years)	Sex (M/F)			MMSE (Mean/SD)	MMSE (Range)			
Soler Marin & Graupera (2011)	Spain	n = 38 (39.5% f)	Cross-sectional	16 - 38 (female M = 23.4; male M = 23.5)	NR	PA levels	N/A	"Validated questionnaire of physical activity" (Relative / Caregiver)	N/A	N/A	N/A	60%
Stancliffe & Anderson. (2017)	USA	n = 8636 (43% f)	Secondary data analysis	18-94	Mild to Profound	PAG	N/A	Survey. Background section of the NCI-ACS; (setting administrator, case managers, direct support providers)	N/A	N/A	N/A	65%
Stanish (2004)	Canada	n = 20 (60% f)	Cross-sectional	19-65	Mild	Steps/day	Yamax Digiwalker pedometers (model SW-500)	N/A	N/A	N/A	N/A	75%
Stanish & Draheim (2005)	Canada	n = 103 (36.9% f)	Cross-sectional	19-65	Mild to moderate	Steps	Yamax Digiwalkers (SW-500 and SW-700)	N/A	N/A	N/A	N/A	95%
Stanish & Draheim. (2007)	Canada	n = 103 (36.9% f)	Cross sectional	19-65	Mild to moderate	Steps / PAG	Yamax Digiwalkers (SW-500 and SW-700)	N/A	< 5000 steps	Yamax Digiwalkers (SW-500 and SW-700)	N/A	85%
Sundahl et al. (2016)	Sweden	n = 52 with intellectual disabilities (51.9% f)	cross-sectional	16-20 (M = 18.2)	Mild to moderate ID	Steps; PAG	2x Pedometers: Keep Walking LS2000 and LS7000 (Yamax SW200/LS2000)	N/A	N/A	N/A	N/A	85%
Temple & Stanish (2009)	Canada	n = 154 (42.3% f)	Secondary data analysis	Males: 18-69 years. Females: 19-57	Mild to moderate	Steps	Yamax digi-walkers (SW-500& 700)	N/A	N/A	N/A	N/A	95%

years.

Abbreviations: NS = not specified; N/A = not applicable; PA = physical activity; SB = Sedentary behaviour; ST = sedentary time; LTPA = leisure time PA; MVPA = moderate to vigorous PA; PAG = physical activity guidelines; cpm = counts per minute; % f = % females; TV = television

Figure. 1. PRISMA flow chart of study selection

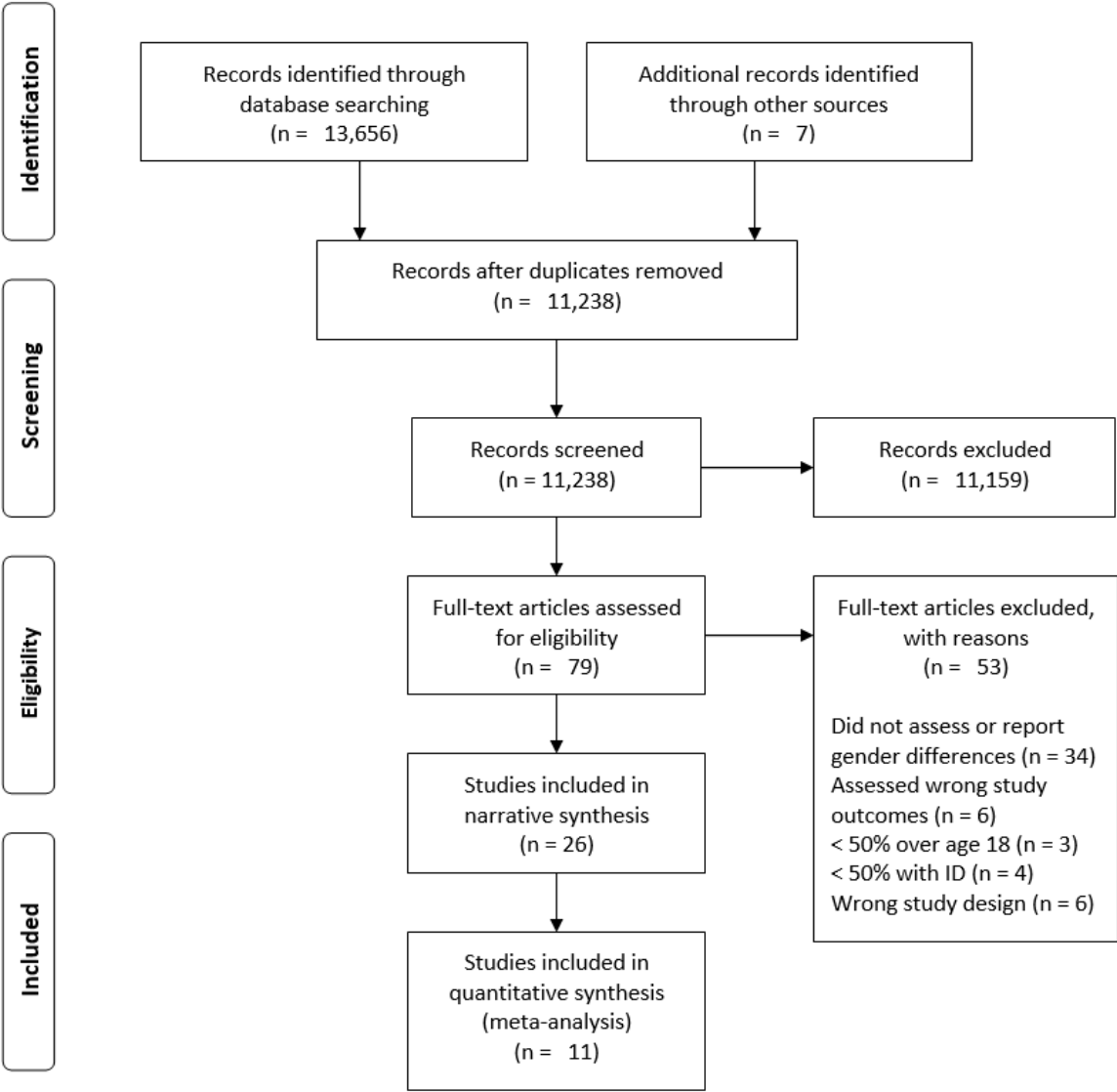


Figure 2. Meta-analysis results and forest plot for gender differences in steps

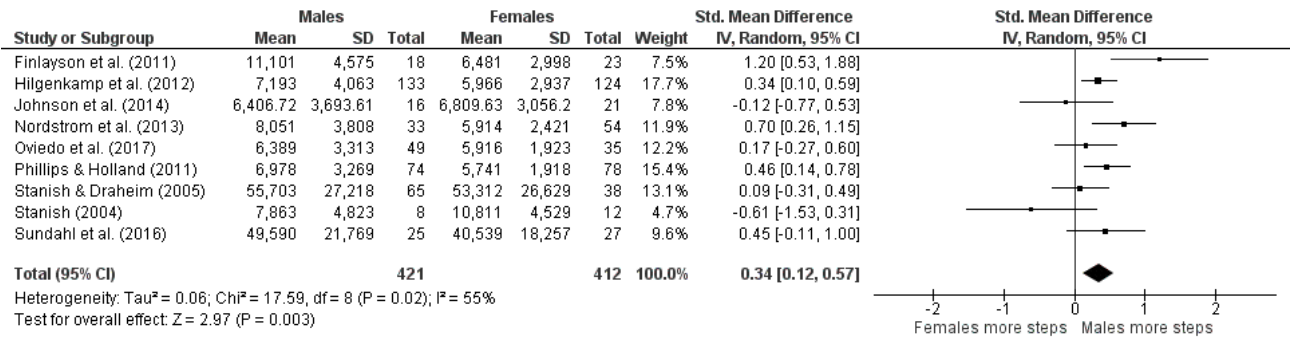


Fig. 3. Meta-analysis results and forest plot for gender differences in MVPA

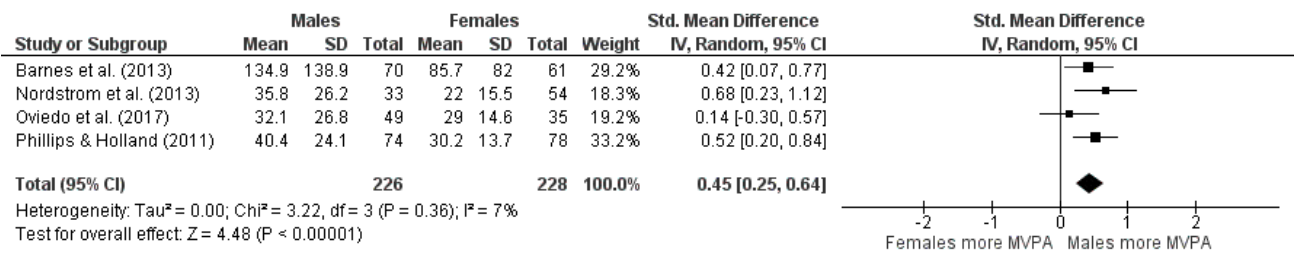
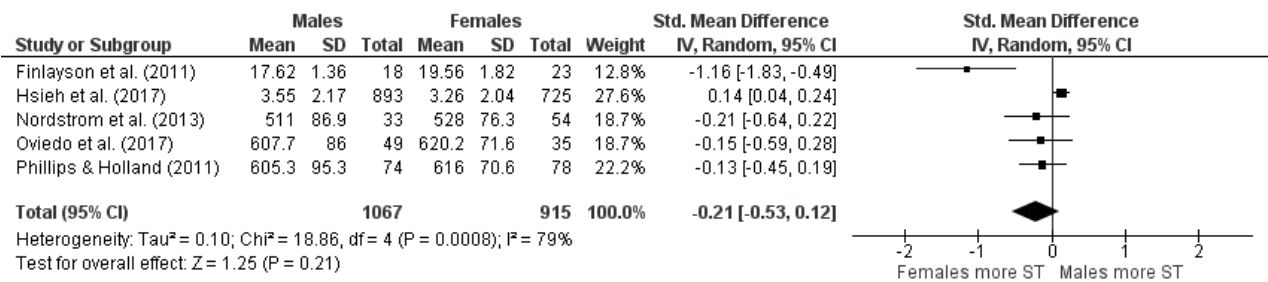


Fig. 4. Meta-analysis results and forest plot for gender differences in ST



Appendix 1. Example Search Strategies

The ovid medline search is an example search strategy that reflects the terms used within each database. Subtle variations in terms arose from exploded terms as these were database specific, and the formatting varied between databases.

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946-present

last ran 29/01/2018

1. exp Intellectual Disability/
2. exp Mentally Disabled Persons/
3. (developmental adj2 (disab* or disorder or difficult*)).tw.
4. (mental* adj2 (retard* or defici*)).tw.
5. (cognitiv* adj2 (defici* or impair*)).tw.
6. (learning adj2 (disab* or disorder or impair* or difficult*)).tw.
7. (intellectual* adj2 (disab* or disorder or impair* or difficult*)).tw.
8. exp Physical Exertion/
9. exp Exercise/
10. exp Sports/
11. Sport*.tw.
12. walk*.tw.
13. physical* activ*.tw.
14. exercis*.tw.
15. Leisure activit*.tw.
16. exp Sedentary Lifestyle/
17. (sedentary adj2 (behaviour or behavior or time)).tw.
18. sedentar*.tw.

19. Physical* inactiv*.tw.
20. sitting time.tw.
21. television watching.tw.
22. television viewing.tw.
23. video viewing.tw.
24. electronic game playing.tw.
25. computer gaming.tw.
26. computer time.tw.
27. "computer use".tw.
28. "PC use".tw.
29. occupational sitting.tw.
30. deskbound.tw.
31. motor* transport.tw.
32. prolonged sitting.tw.
33. 1 or 2 or 3 or 4 or 5 or 6 or 7
34. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
35. 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or
31 or 32
36. 34 or 35
37. 33 and 36
38. limit 37 to (full text and humans and "all adult (19 plus years)" and English)

Appendix 2. Weighted Average Example

The table below shows the weighted average calculated for daily MVPA, using the number of males and females within a sample as a weight.

Study	Sample size		Weight		Daily MVPA		Weighted MVPA	
	Males	Females	Males	Females	Males	Females	Males	Females
Nordstorm et al. 2013	33	54	0.212	0.323	35.8	22	7.59	7.106
Oviedo et al. 2017	49	35	0.314	0.21	32.1	29	10.079	6.09
Phillips & Holland. 2011	74	78	0.474	0.467	40.4	30.2	19.15	14.103
Total	156	167	1	1			36.8	27.3